

BLACKSTONE RIVER FLOOD CONTROL

LOWER WOONSOCKET  
LOCAL PROTECTION PROJECT

DRAINAGE STUDY - HAMLET DISTRICT PUMPING STATION AREA

CHARLES A. MAGUIRE & ASSOCIATES  
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April 16, 1962

REPLY TO: Providence

Division Engineer  
U. S. Army Engineer Division  
New England  
Corps of Engineers  
424 Trapelo Road  
Waltham 54, Massachusetts

Attention: Mr. Edwin F. Coffin, Project Engineer

Re: Contract No. DA-19-016-CIVENG-62-224  
Drainage Study - Hamlet District  
Line Item No. 3 - Lower Woonsocket  
Local Protection Project, Woonsocket, Rhode Island

Dear Sir:

In accordance with the provisions of our contract agreement dated 12 March 1962, we have prosecuted a study of the interior drainage area to be served by the Hamlet District pumping station.

This report is based on data recorded by field reconnaissance to establish the limits of the natural drainage area. In addition, data available from city records were supplemented by field reconnaissance to establish the extent of the existing storm drainage system. This investigation included the establishment of the principal storm drains which will require interception for discharge to the pumping station. Data were recorded as to pipe types, sizes, grades and pipe capacities were estimated. In addition, investigations were made to determine the drainage contribution originating outside the natural drainage area. The results are included in tabular form and the data are also presented on a plan of the drainage system to permit checking of any individual component of the system.

This investigation included the establishment of those storm drains which reduce the natural runoff of the drainage area by virtue of discharging outside of the natural drainage area.

Division Engineer

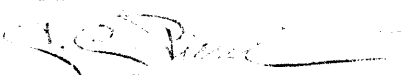
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April 16, 1962

The runoff factors for divisional portions of the natural drainage area were established by field reconnaissance and the accompanying text and data substantiate the reasons for the appropriate selections.

Very truly yours,

CHARLES A. MAGUIRE & ASSOCIATES

  
F. C. Pierce

FCP:FH

GENERAL - A substantial portion of the lower section of the City of Woonsocket referred to as the Hamlet District in the Interim Report dated May 29, 1957, is to be enclosed by dikes and flood walls when the Lower Woonsocket Flood Control Project is constructed.

This study, of the interior drainage area and its special features, has been prosecuted for use in the determination of the capacity of the pumping station and possible inundation elevations behind the protective works during storms of various magnitudes.

DESCRIPTION OF STUDY AREA - The area to be protected in the Hamlet District consists of a concentration of industries located on the flood plain along the Hamlet Trench and the Blackstone River. Although this area is small in size, there is a considerable acreage adjacent to it that will contribute storm water runoff into the protected area during any storm that occurs while the Blackstone River is in its flood stages.

TOPOGRAPHY - The total contributing drainage area within the district is 181 acres. The thirty to thirty-five acres immediately adjacent to the Hamlet Trench are relatively flat and consist of mill buildings with flat roofs and partially paved or graveled areas. The middle of this area consists of a high concentrated residential section with a series of very steep connecting streets, having grades ranging up to 22 percent. Grass and other ground cover is sparse, and ledge is exposed in some areas. The upper portion of the area is moderately steep, and a good part of it is occupied by a school and its supporting facilities. Ledge is exposed conspicuously in this area, and ground cover is

sparse. A large new school building is in the process of being constructed between the easterly side of the existing school and Mount Saint Charles Avenue. It should also be noted that the only remaining area to be developed is bounded by Manville Road, Mount Saint Charles Avenue, the school property, and Bernon Street. Any additional construction in this area will tend to increase the runoff.

EXISTING DRAINAGE SYSTEM - The existing underground drainage system consists of three separate sections. The first drains the Park Place-Morton Avenue area (Drainage Area No. 6 Plate A-5) with a series of curb inlet type catch basins and a 15-inch vitrified clay line down Villanova Street to a low point. A 24-inch vitrified clay line runs from the low point northeasterly down Villanova Street into a drop manhole at the Kendrick Avenue footbridge and then under the Hamlet Trench into the Blackstone River. The controlling features of this line are, (1) the ability of the catch basins on the steep section of Villanova Street to intercept the flow before it reaches the low point and (2) the capacity of the 24-inch vitrified clay outfall. The second system (Drainage Area No. 3 Plate A-5) begins far up in this drainage area at the intersection of Washington Street and Maple Street. It extends down Maple Street for about 950 feet in a series of steep 15-inch vitrified clay lines and ties into a 20-inch vitrified clay line just beyond Willow Street. A succession of curb inlet type catch basins intercept the flow and discharge into the line. The catch basins at the upper section of Maple Street have "D" type grates on them, but there is evidence that during

heavy flows a portion of the water bypasses them because of the 20 percent grade of the street. The 20-inch vitrified clay line goes down Carrington Street to Welles Street, where it intercepts a 20-inch vitrified clay line from Welles Street. It then continues as a 20-inch line down Welles Street to Hamlet Avenue, where it increases to a 27-inch and then to a 30-inch line in Hamlet Avenue. The 30-inch vitrified clay line runs down Hamlet Avenue to and up Manville Road, where it ties into a 4.5 feet by 4.5 feet stone box culvert which runs under the railroad track. Just northeasterly of the railroad tracks the stone box is open at the top for a short section, and from this a 36-inch circular brick sewer originates and runs down Hamlet Avenue to a manhole near the Hamlet Trench. It then runs under the trench in a 36-inch corrugated metal culvert at a fairly flat slope. The low point on Hamlet Avenue in front of the French Worsted Mills is protected by a series of nine catch basins and grates on the northwesterly side and two catch basins with curb inlets and grates on the southeasterly side. These inlets were installed when the Hamlet Avenue Bridge was rebuilt to catch the storm water that bypasses the inlets on Hamlet Avenue and its side streets. The lines from these inlets tie into a 54-inch reinforced concrete pipe which in turn connects to the 60-inch reinforced concrete pipe that joins the two sections of the Hamlet Trench under the new bridge. The upper section of the 54-inch line has a plugged stub for possible interception of the 36-inch brick sewer. Two 12-inch storm lines run out of the French Worsted Mill property and down Hamlet Avenue under the Hamlet

Trench and into the Blackstone River. The weak points in this drainage system are, (1) the ability of the catch basins to intercept the flow, (2) the ability of the series of new catch basins and the special 9-grate structure at the low point of Hamlet Avenue to intercept the flow without considerable ponding, and (3) the flat grade of the 36-inch corrugated pipe under the Hamlet Trench. A series of catch basins with grates and curb inlets was proposed for the area from Morton Avenue down and along Hamlet Avenue to the low point by the State of Rhode Island when the Hamlet Avenue Bridge was built, but these units were never constructed. It should be noted at this time that any flow not picked up by the catch basins on the streets south of the railroad will be concentrated at the intersection of the railroad, Hamlet Avenue, and Manville Road, with a portion crossing the railroad tracks and going down Hamlet Avenue, and a portion being intercepted by the railroad and flowing southwesterly along the track and passing through a 12-inch culvert down onto Davison Avenue. The third drainage area consists of two subareas (Drainage Areas No. 1 and No. 2 Plate A-5) and is divided into three subsections, the first of which begins at the intersection of Bennett Street and Carrington Avenue and runs in a 15-inch vitrified clay line down Carrington Avenue to Manville Road, up Manville Road to a manhole at the intersection of Manville Road and Davison Avenue. The second section begins at the extremes of the drainage area on Monroe Street and runs cross country by the school to Bernon Street, then down Bernon to Roberts Street, down Roberts Street to Willow Street, down

Willow to the manhole at Davison Avenue and Manville Road. This complete line is 15-inch vitrified clay pipe except for one small 20-inch section at the school. The third section runs from Mount Saint Charles Avenue all the way down Manville Road to the manhole at Davison Avenue. Although Manville Road was rebuilt in 1960 by the State of Rhode Island, the trunk main was left intact and new Rhode Island standard curb inlet or curb inlet with grating type catch basins were tied into the main. This line is 18-inch vitrified clay all the way to Bernon Street, where it increases to a 24-inch vitrified clay line, then decreases to a 20-inch vitrified clay before it ties into the manhole at Davison Avenue. From the existing manhole at Manville Road and Davison Avenue an 18-inch line runs down Davison Avenue to a manhole in the street opposite the entrance to the dump, and then a 20-inch vitrified clay line runs down dump road and into the Blackstone River. As might be expected, the cover of the manhole at the dump road and Davison Avenue has been reported to be blown off by hydraulic pressure during heavy storms. The critical points in this drainage system are as before, (1) the ability of the curb inlets to intercept the gutter flows and (2) the pipe capacities. Manville Road will intercept the storm water from all but the severest storms, but it is doubtful if the catch basins have the capacity to intercept the runoff from the relatively steep side roads. This water will concentrate at the intersection of Manville Road and Davison Avenue and run down Davison Avenue in the gutters and then into the Hamlet Trench. Davison Avenue and Florence Drive intercept a good

portion of the runoff from drainage areas No. 4 and No. 5 (Plate A-5) and discharge them directly into the Hamlet Trench.

CAPACITY OF THE EXISTING STORM DRAINAGE SYSTEM - The capacities of the existing storm drain lines were determined for the pipes flowing full at their given slopes. Manning's "n" values used were 0.013 for vitrified clay pipe, 0.015 for brick pipe, and 0.024 for corrugated metal pipe. In many cases the very steep slope of the pipe gave a large theoretical value of "Q". An analysis of these cases was made to estimate what a practical flow in the pipes would be, assuming that in the average manhole a three foot surcharge could be obtained without forcing off the manhole covers by hydraulic pressure. Table 2 shows the entrance capacity of the pipes under various surcharges and the estimated maximum flow capacity of the various sizes. The values of theoretical maximum flow capacity and estimated maximum capacity are shown on Plate (A-5) adjacent to the applicable line.

The standard Woonsocket catch basin used in this area is of the curb inlet type with no grate. The curb inlets are about 4 feet long with a 4- to 8-inch high opening. Most of the curb inlets have a depressed gutter area in front of them, with an average depression of about 0.3 of a foot. Manville Road has been rebuilt recently, and Rhode Island standard curb inlet catch basins with and without grates have been used. The curb inlet type has a 32-inch gutter opening 4 to 6 inches high. The gutters are depressed about 2 inches in front of the inlet. By use of charts developed by the Bureau of Public Roads

(Plate A-1), a graph of gutter flow versus percent intercepted by curb inlet was plotted for each type of inlet at various gutter slopes with a constant cross slope of 3/8 inch per foot (Plates A-2 and A-3). It can be seen that for any appreciable flows on the steeper grades, it is possible for a considerable portion of the flow to bypass the inlet. The addition of grates increases the interception considerably in all cases.

STORM RUNOFF - Storm runoff was calculated for each of the six individual drainage areas and for the total drainage area involved in this study. Drainage areas were determined from field reconnaissance and aerial photogrammetric sheets. Values of coefficients were determined by field reconnaissance and experience as were estimates of concentration times.

The rainfall intensity - duration relationships were developed by interpolating the values given in Technical Paper No. 40 - Rainfall Frequency Atlas of the United States, published in May 1961 by the United States Department of Commerce. (Table 3 and Plate A-4).

The values obtained from this information agree very closely with those developed by David Yarnell in United States Department of Agriculture Publication No. 204.

The storm water runoff was determined by the use of the Rational Formula  $Q = C I A$

Q = Runoff - Peak discharge of watershed in cubic  
feet per second.

C = Coefficient of runoff.

I = Maximum average rainfall intensity in inches  
per hour based on concentration time.

The values of C were estimated by evaluating the slope, type of area, degree of saturation, compaction, surface irregularity, character of subsoil, and possible build-up of the area studied. The "C" value was further altered with the frequency of the storm. A higher "C" value was used for the more intense storms. Consideration was given to detention and storage on flat roofs, graveled and paved surfaces. No estimate was made for ponding in the upper area. The only significant ponding that will occur is in that portion of the Hamlet Trench that will be left intact after the construction of the dikes. The area left could provide a considerable amount of storage.

Storms of 2 year, 5 year, 10 year, 25 year, and 50 year frequency were studied. The estimated values of "C" and runoff for the various areas under the five storm conditions are shown in Table 1.

CONTRIBUTIONS FROM OUTSIDE OF THE NATURAL DRAINAGE AREA - An analysis of the total Hamlet District Area indicates that there is no significant contribution of storm water runoff from outside of our natural drainage area.

REDUCTION OF NATURAL RUNOFF - Investigation of the existing storm drains indicates that the trunk line down Davison Avenue from the intersection

of Manville Road and Davison Avenue can be utilized to reduce the contribution into the protected area. It is evident that the 18-inch section down Davison Avenue and the 20-inch section to the river are not adequate to take the flow coming into them and should be increased sufficiently in size to carry the 40 to 45 c.f.s. that the two 15-inch and one 20-inch line are capable of delivering to it. This should be a pressure type conduit and it can then be run under the proposed dike and discharge into the Blackstone River.

CHARLES A. MAGUIRE & ASSOCIATES

<u>No.</u>	<u>Area Acres</u>	<u>Frequency (Years)</u>	<u>Conc. Time</u>	<u>Rainfall In/Hr</u>	<u>C</u>	<u>Runoff c.f.s.</u>
1	56	2	35.5	1.50	.35	29
		5		2.10	.38	41
		10		2.70	.40	60
		25		3.10	.45	78
		50		3.55	.50	99
2	41.5	2	26.6	1.78	.45	33
		5		2.50	.48	50
		10		3.20	.50	66
		25		3.71	.55	85
		50		4.20	.60	105
3	44	2	25	1.83	.45	36
		5		2.60	.48	55
		10		3.33	.50	75
		25		3.85	.55	93
		50		4.35	.60	115
4	12.7	2	15	2.45	.65	20
		5		3.45	.68	30
		10		4.35	.70	39
		25		5.00	.75	48
		50		5.60	.80	57
5	12	2	15	2.45	.65	19
		5		3.45	.68	28
		10		4.35	.70	36
		25		5.00	.75	45
		50		5.60	.80	58
6	15	2	20	2.10	.55	17
		5		2.95	.58	26
		10		3.80	.60	34
		25		4.35	.65	42
		50		4.90	.70	52
Total	181	2	35.5	1.78	.45	145
		5		2.50	.48	217
		10		3.20	.50	290
		25		3.71	.55	369
		50		4.20	.60	455

TABLE I

RUNOFF

Entrance Capacity of Pipe Culverts (Neglecting Velocity of Approach)

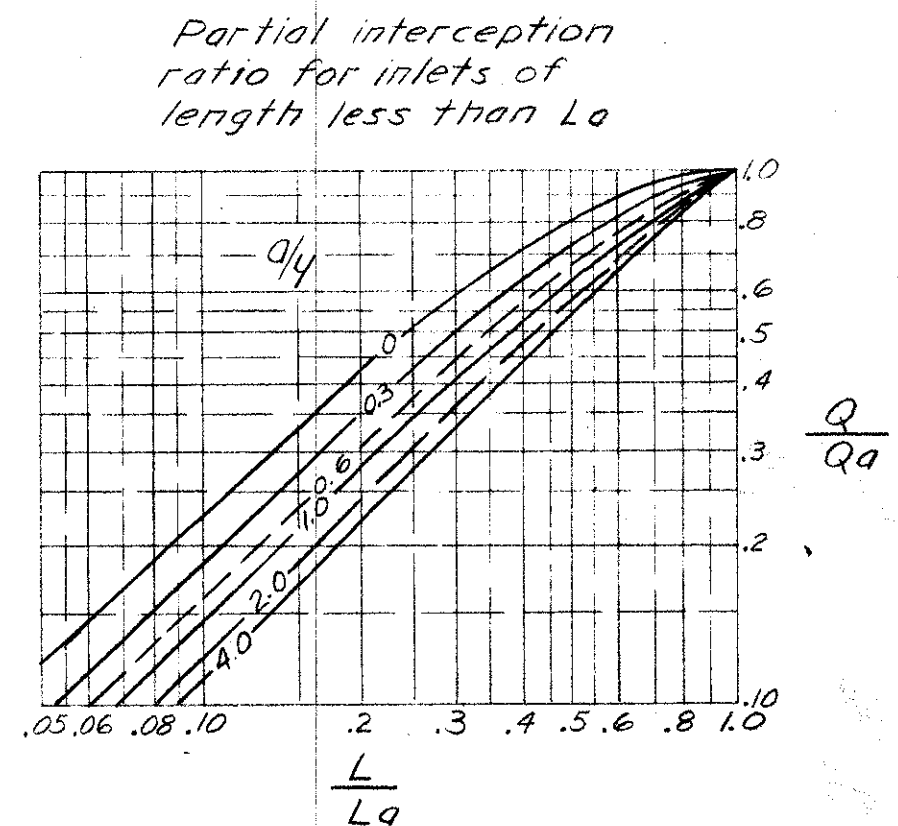
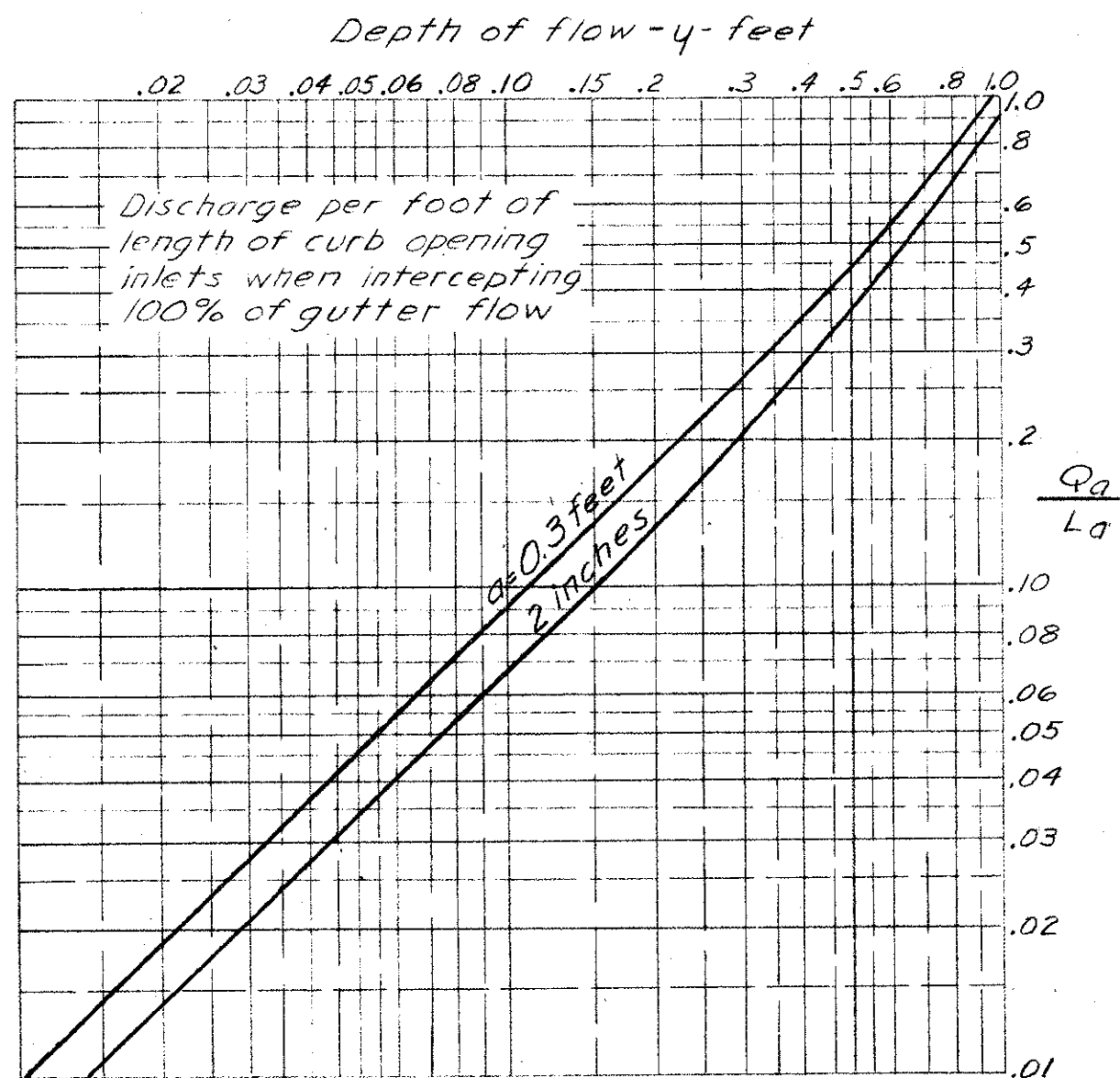
<u>Pipe Size</u>	<u>Surcharge</u>	<u>Capacity in c.f.s.</u>	<u>Estimated Max. Value to be used assuming 3' of surcharge</u>
15"	0	3.6	11 c.f.s.
	1	7.3	
	2	9.5	
	3	11.25	
18"	0	5.9	17 c.f.s.
	1	11.0	
	2	14.0	
	3	17.0	
20"	0	8.0	21 c.f.s.
	1	14.0	
	2	18.0	
	3	21.0	
24"	0	12.5	31 c.f.s.
	1	20.0	
	2	27.0	
	3	31.0	
	4	35.0	
30"	0	21.0	48 c.f.s.
	1	34.0	
	2	43.0	
	3	48.0	
	4	56.0	
36"	0	34.0	70 c.f.s.
	1	50.0	
	2	62.0	
	3	70.0	
	4	80.0	

TABLE II

RAINFALL AND RAINFALL RATES FOR PLOTTING  
THE RAINFALL INTENSITY-DURATION-FREQUENCY CURVES  
FOR THE WOODSOKET, RHODE ISLAND AREA

TIME	2 yr.		5 yr.		10 yr.		25 yr.		50 yr.	
	RAINFALL RATE	RAINFALL RATE	RAINFALL RATE	RAINFALL RATE	RAINFALL RATE	RAINFALL RATE	RAINFALL RATE	RAINFALL RATE	RAINFALL RATE	RAINFALL RATE
5 min.	.32	3.84	.46	5.51	.56	6.75	.64	7.70	.72	8.62
10 min.	.49	2.94	.71	4.26	.86	5.16	.99	5.95	1.11	6.66
15 min.	.62	2.48	.90	3.60	1.08	4.32	1.25	5.00	1.40	5.60
30 min.	.85	1.70	1.25	2.50	1.50	3.00	1.73	3.46	1.94	3.98
1 hr.	1.06	1.06	1.52	1.52	1.92	1.92	2.16	2.16	2.50	2.50
2 hrs.	1.37	.68	1.97	.98	2.40	1.20	2.85	1.42	3.15	1.58
3 hrs.	1.54	.51	2.30	.73	2.75	.92	3.10	1.03	3.46	1.15
6 hrs.	1.98	.33	2.78	.46	3.35	.56	3.90	.65	4.25	.71
12 hrs.	2.38	.20	3.31	.28	4.00	.33	4.70	.39	5.20	.43
24 hrs.	2.86	.12	4.03	.17	4.75	.20	5.50	.23	6.30	.26

TABLE III



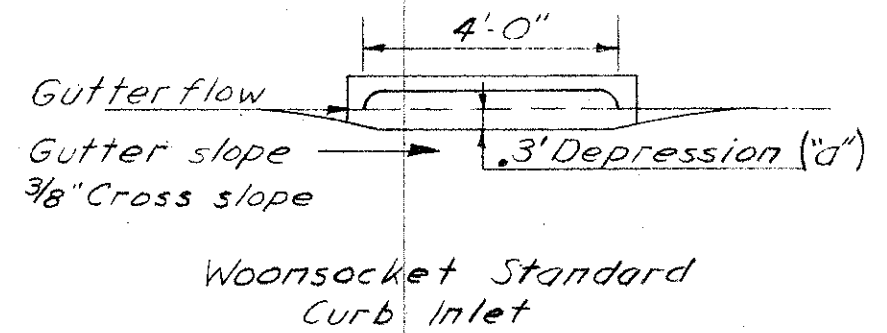
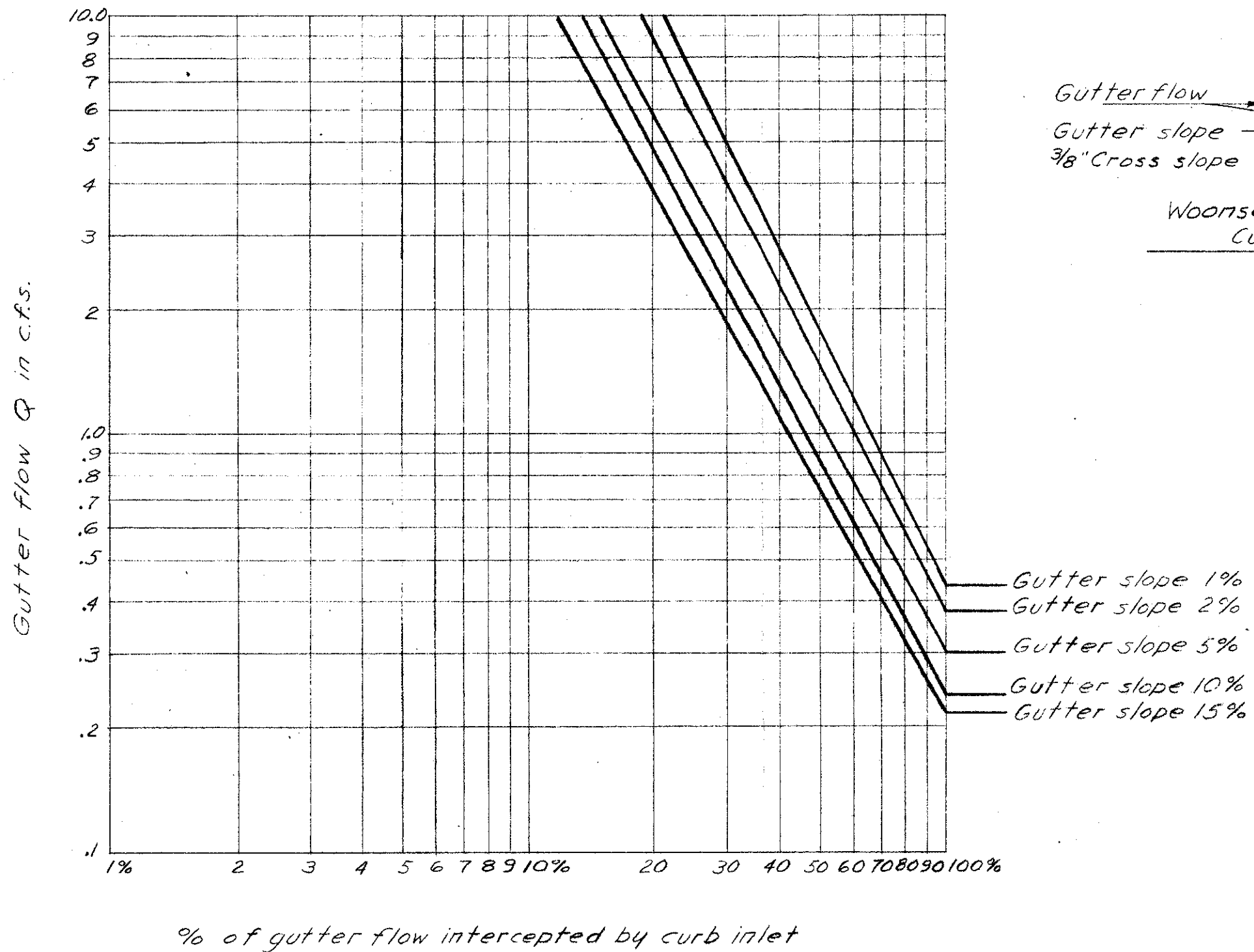
BLACKSTONE RIVER FLOOD CONTROL  
LOWER WOONSOCKET

CAPACITY OF CURB OPENING  
INLETS ON CONTINUOUS GRADES

CHARLES A. MAGUIRE & ASSOCIATES  
APRIL, 1962

Charts from Bureau of Public Roads

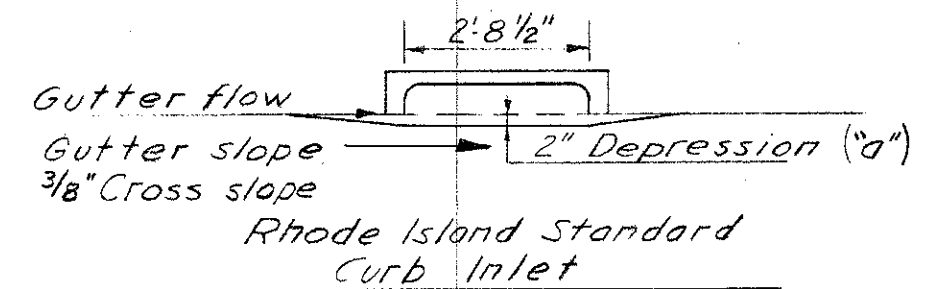
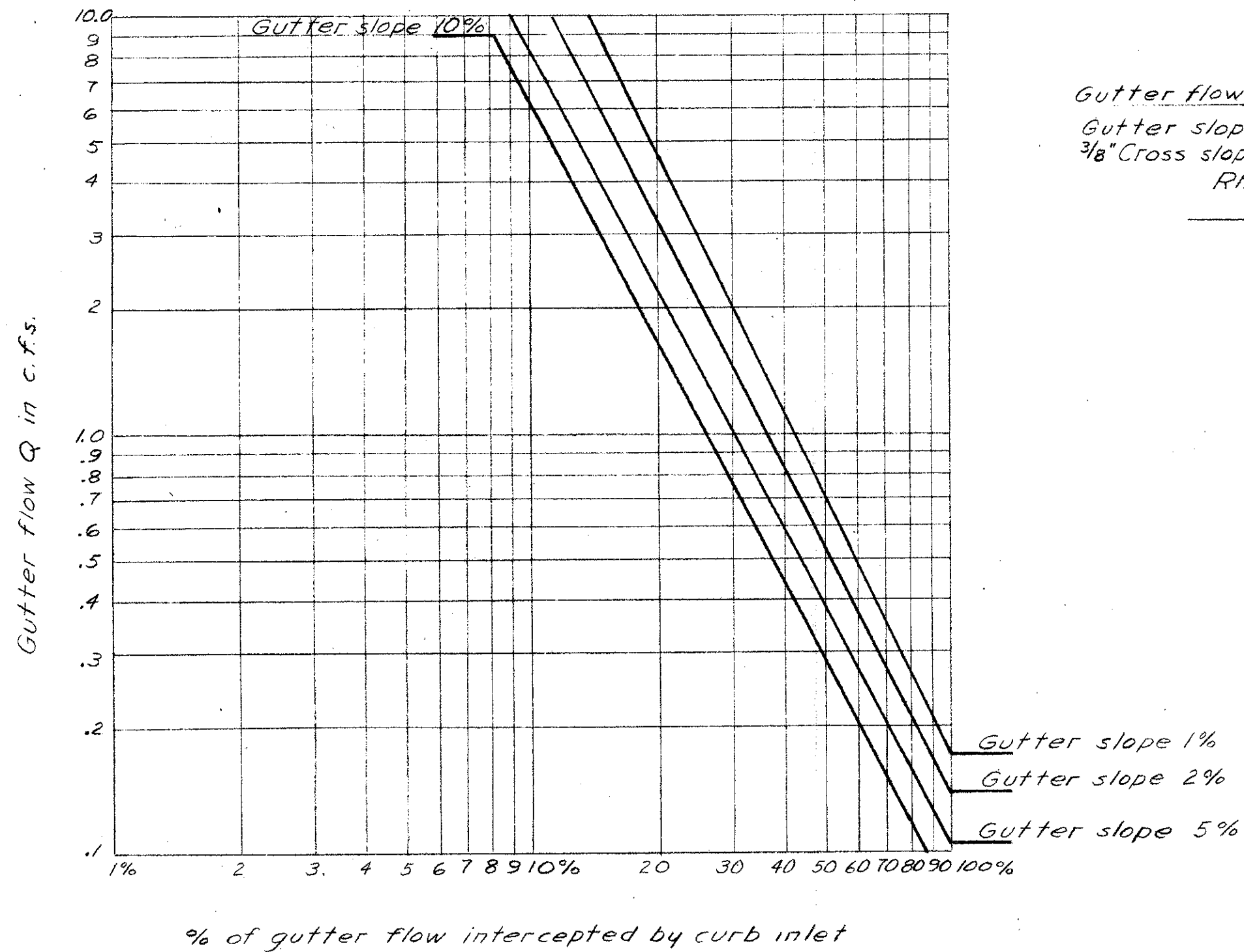
PLATE A-1



BLACKSTONE RIVER FLOOD CONTROL  
LOWER WOONSOCKET

**CAPACITY OF WOONSOCKET  
STANDARD CURB INLET**

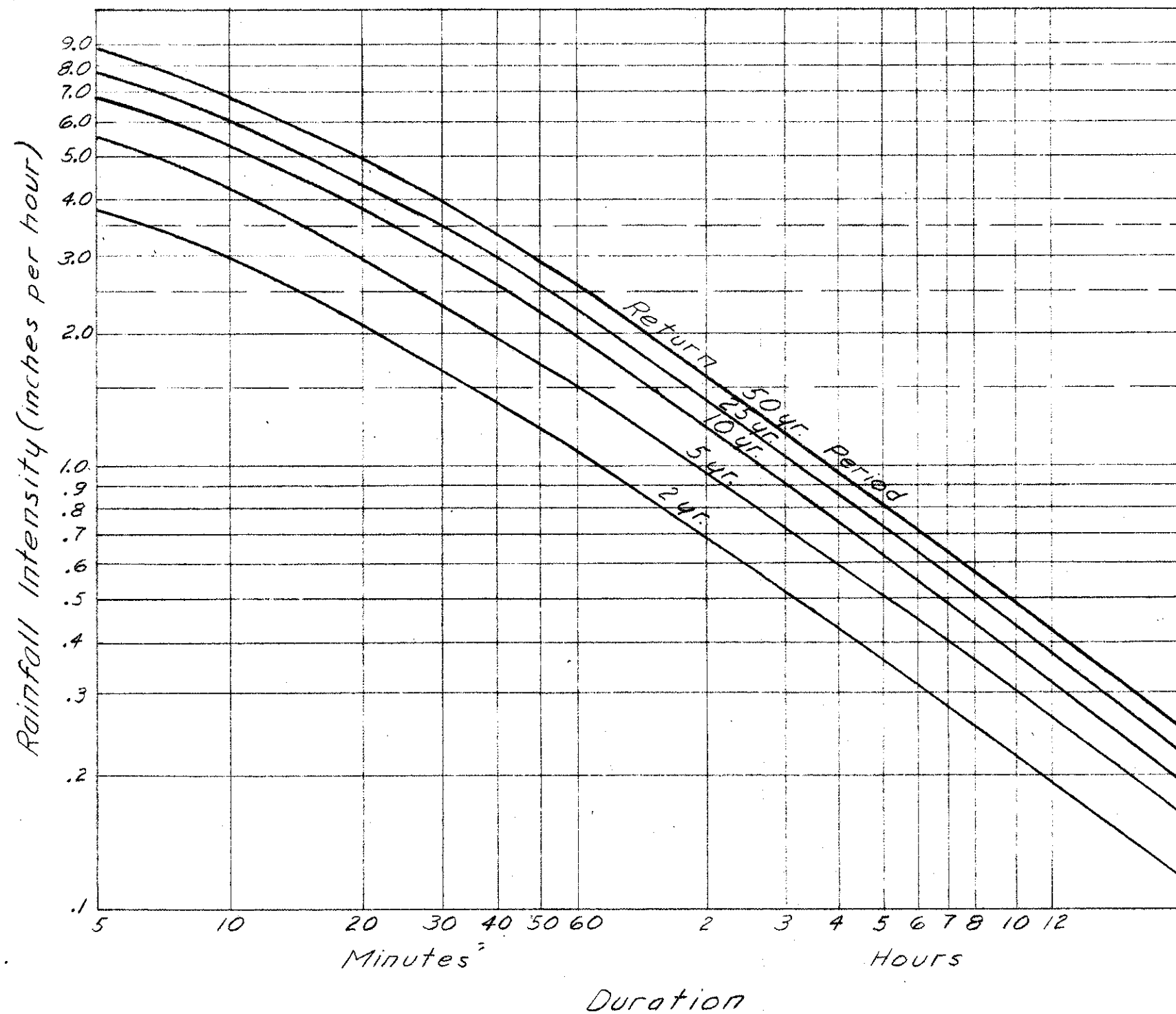
CHARLES A. MAGUIRE & ASSOCIATES  
APRIL, 1962



BLACKSTONE RIVER FLOOD CONTROL  
LOWER WOONSOCKET

# CAPACITY OF RHODE ISLAND STANDARD CURB INLET

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APRIL, 1962



BLACKSTONE RIVER FLOOD CONTROL  
LOWER WOONSOCKET

RAINFALL INTENSITY — DURATION  
FREQUENCY CURVES  
FOR WOONSOCKET

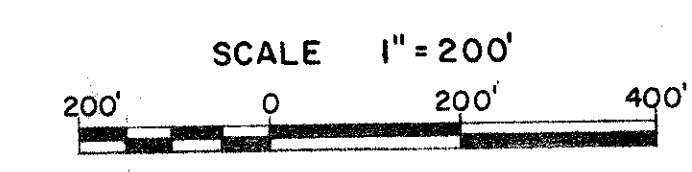
CHARLES A. MAGUIRE & ASSOCIATES  
APRIL, 1962



- Legend**
- DMH Storm Drain Manhole
  - C.B. Catch Basin or Curb Inlet
  - S.D. Storm Drain Line with Flow Arrow
  - Outline of Total Drainage Area
  - Outline of Sub-Drainage Area
  - Surface Water Flow Directions in Gutters

- Notes**
1.  $Q_r$  value shown is theoretical capacity of storm drain flowing full at the given slope.
  2.  $Q_a$  value shown is estimated maximum flow in storm drain assuming a 3" surcharge as a maximum.
  3. 25 foot contours and spot grades are approximate and are shown for informational purposes only.
  4. Storm drains outside of our drainage area are shown for informational purposes only.

**GENERAL PLAN**



REVISION	DATE	DESCRIPTION	BY
CHARLES A. MAGUIRE & ASSOCIATES PROVIDENCE, R.I. HARTFORD, CONN. BOSTON, MASS.		U.S. ARMY ENGINEER DIVISION, NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.	
ARCHITECT-ENGINEER		ARCHITECT-ENGINEER	
DES. BY DR. BY CK. BY		SUBMITTED	
PROJECT ENGINEER		ARCHITECT-ENGINEER	
APPROVAL RECOMMENDED		APPROVAL RECOMMENDED	
CHIEF, DESIGN BRANCH		CHIEF, ENGINEERING DIVISION	
APPROVAL RECOMMENDED		APPROVED	
CHIEF, P & R BRANCH		DATE	
		SCALE	
		SPEC. NO.	
		DRAWING NUMBER	
		SHEET	

**BLACKSTONE RIVER FLOOD CONTROL  
LOWER WOONSOCKET  
HAMLET DISTRICT DRAINAGE STUDY  
GENERAL PLAN**

BLACKSTONE RIVER RHODE ISLAND